Capacitor Ripple Current Heating and Expected Life

Power loss of an electrolytic capacitor from its ripple current and ESR, its core temperature rise, and the expected life by the 10 °C doubling rule.

Method: Ripple heating and the 10 K life-doubling rule for aluminium electrolytic capacitors

Input parameters

Unit system: SI

Parameter	Value	Unit
Ripple current (RMS)	2.5000	A
Equivalent series resistance at the ripple frequency	50.000	mΩ
Thermal resistance core to ambient (K/W)	18.000	
Ambient temperature	55.000	°C
Rated temperature	105.00	°C
Rated life at the rated temperature	5,000.0	h

Calculated results

Parameter	Value	Unit
Power loss	0.31250	W
Core temperature rise	5.6250	K
Core temperature	60.625	°C
Expected life	108,340	h
Expected life in years of continuous operation	12.368	

Notes for this case

• Ripple current heats the capacitor through its ESR, P = I²ESR, raising the core above ambient by P × R_th. Electrolyte loss follows Arrhenius behaviour, which for aluminium electrolytics is usually expressed as life doubling for every 10 K below the rated temperature. Use the ESR at the ripple frequency and the expected temperature (it rises in the cold and as the capacitor ages), and the maker's thermal resistance or ripple rating for R_th.

Formula and method

$$P = I_{rms}^2\, ESR, \quad T_c = T_a + P R_{th}, \quad L = L_0\, 2^{(T_r - T_c)/10}$$

Variables

I_{rms}	Ripple current (RMS)	A
ESR	Equivalent series resistance at the ripple frequency	Ω
R_{th}	Thermal resistance core to ambient (K/W)	-
T_a	Ambient temperature	K
T_r	Rated temperature	K
L_0	Rated life at the rated temperature	s
P	Power loss	W
ΔT	Core temperature rise	K
T_c	Core temperature	K
L	Expected life	s
L_y	Expected life in years of continuous operation	-

Method and standards

Capacitor life.

Assumptions and limits

- Steady ripple and temperature; 10 K doubling rule.

References

Ripple heating and the 10 K life-doubling rule for aluminium electrolytic capacitors

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/electronics/capacitor-ripple-esr-heating

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Reopens the calculator with the inputs of this report.